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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : B07C 3/14

A1

(11) International Publication Number: WO 98/32545

(43) International Publication Date: 30 July 1998 (30.07.98)

(21) International Application Number: PCT/US98/01366

(22) International Filing Date: 23 January 1998 (23.01.98)

(30) Priority Data:

08/787,974	23 January 1997 (23.01.97)	US
08/788,852	23 January 1997 (23.01.97)	US

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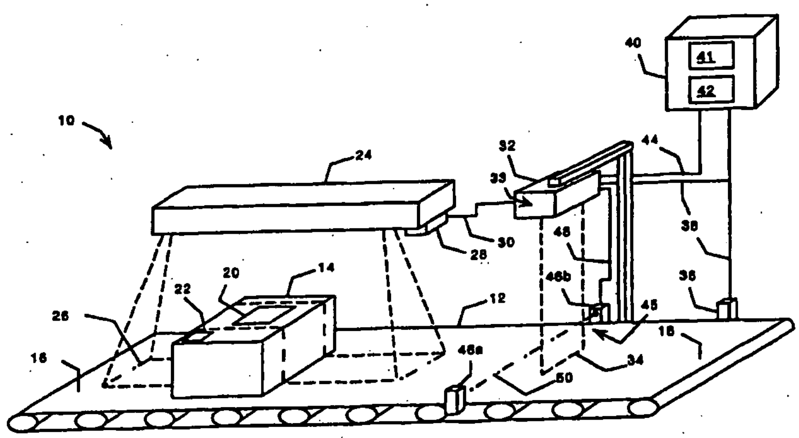
(81) Designated States: CA, JP, European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

Published

With international search report.
Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.

(54) Title: OPTICALLY-GUIDED INDICIA READER SYSTEM



(57) Abstract

An optically-guided indicia reader (10) system including a conveyor (12) carrying a parcel (14) bearing a destination address (20). An illumination source (24) defines a area (26) to assist the positioning of the parcel (14) on the conveyor (12). A scanner (32) and a computer memory (42) of a character recognition system (40) are operated so as to store an image of a region defined with respect to the moving illuminated area (26). A sensor assembly (28), including a height sensor and reflectivity sensor, is located toward the downstream location of the illumination source (24). The scanner (32) includes internal components (33) well known to those skilled in the art that automatically focuses the scanner in response to height data, and adjusts the gain of the scanner (32) in response to reflectivity data, so that the scanner (32) generates a clear image of the top of the parcel (14) as the parcel passes beneath the scanner (32). A photo sensor (45) is positioned upstream from the scanner (32) to detect the presence of the parcel (14). The video data generated by the scanner (32) may be stored in the computer memory (42) only when the beam (50) of the photo sensor (45) is broken. A time delay may be imposed to account for the distance between the beam (50) and the scan line (34). Alternatively, a moving-light illumination source (224) defines a spot (230) that moves at the same speed as the conveyor (212) to assist the positioning of the parcel (214) on the conveyor (212).

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OPTICALLY-GUIDED INDICIA READER SYSTEM

Technical Field

The present invention relates to image processing and more particularly relates to over-the-belt optical character recognition (OCR) systems. Specifically, the invention relates to an indicia reader system that includes a projected optical guide to assist the positioning of parcels on a conveyor.

Background of the Invention

For years, machines have been used to scan parcels as they travel along a conveyor. Over-the-belt optical character recognition (OCR) systems have been recently developed that can read indicia, such as a typed or hand-written destination address on parcels to be shipped. Parcel delivery companies, such as United Parcel Service, ship millions of parcels every day. These parcel delivery companies make extensive use of OCR systems to read the destination address labels on parcels to facilitate sorting and routing the parcels to their proper destinations.

The fundamental physical components of an OCR system are a scanner and a character recognition system including a central processing unit (CPU), a computer memory, and a sophisticated character recognition program module. The scanner is typically an optical camera, such as a charge-coupled device (CCD) array, that captures an image of the destination address on the parcels as they travel past the scanner on the conveyor. Generally, a continuous video image of the conveyor carrying the parcels is captured by the scanner, which video image is converted into digital format and transmitted to the character recognition system. But only a small part of the video image, such as the portions including the destination addresses of the parcels, needs to be processed by the character recognition system. The OCR system, therefore, must have some way to identify the portions of the video image that need to be processed by the character recognition system.

One approach is to store the entire video image created by the scanner, and later parse out the portions of the video image that need to be processed by the character recognition system. But a continuously running scanner generates an enormous amount of video data. This data is formatted as a continuous bit map of the conveyor as the conveyor carries parcels past the scanner. This bit map inherently conveys information about the spatial relationship of the pixels of the image. Storing this continuous bit map requires an enormous amount of computer

memory. It is therefore advantageous to reduce the memory storage requirement.

Data compression is one technique for reducing the memory storage requirement. The video data may be compressed for storage using any of a variety of well known data compression methods, such as run length encoding. These data compression techniques, however, alter the bit-map format of the data. This is undesirable because it is advantageous for the character recognition program module to operate on bit maps that allow easy access to information regarding neighborhoods around individual pixels. The compressed data must therefore be uncompressed, typically into a frame buffer, for processing by the character recognition program module. Compressing the video data for storage, and then uncompressing the video data for processing, burdens the CPU and slows the character recognition process.

Real-time extraction of the desired portions of the video data is another technique for reducing the memory storage requirement. Indeed, real-time data extraction is a very effective technique because most of the video data created by the continuously running scanner is a useless image of the conveyor and the non-indicia bearing areas of the parcels moving along the conveyor; only a small percentage of the data includes the destination addresses of the parcels to be shipped. Therefore, extracting only small portions of the video data, such as relatively small areas covering the destination addresses, greatly reduces the memory storage requirement and speeds up the character recognition process.

Systems have been developed for triggering a video camera system so as to store only desired video images. For example, *Tonkin*, U.S. Patent No. 4,742,555, describes a mechanical limit switch, optical sensor, or magnetic sensor that triggers a video system to capture and store an image of a parcel as the parcel reaches a predetermined location along a conveyor. But the system described by *Tonkin* would have a significant drawback if applied to a parcel shipping system. This is because the system described by *Tonkin* captures an image of the entire parcel; is not operative for capturing only a specific portion of the image, such as the destination address. In a parcel shipping system, the destination address must be captured for sorting and routing purposes, but other indicia on the parcel, such as the return address, is not needed to route the parcel to its proper destination. It is therefore advantageous to identify the destination address prior to storing the image of the parcel, so that only the portion of the image containing the destination address may be stored in the computer memory.

Several difficulties are encountered, however, in attempting to identify the destination addresses on various parcels traveling on a conveyor. First, the destination addresses may vary in size, and may be in different locations on different parcels. Second, the parcels themselves may vary in size, shape, and position on the conveyor. Thus, the exact position of a destination address on a parcel cannot be determined by simply detecting the edge of the parcel using a limit switch or sensor, as described by *Tonkin*.

Systems have been developed for storing video images of selected portions of parcels traveling of a conveyor. For example, *Kizu et al.*, U.S. Patent No. 4,516,265, describes a two-camera system that reads the postal (zip) codes on envelopes traveling on an envelope transport

system. The system includes a low resolution prescanner that coarsely scans the surface of the envelope. The position of the destination address block is determined from the coarse scan, and the coordinates of the destination address block with respect to the leading edge of the envelope are then passed to a second, high-resolution camera system. The second camera system stores an image of the destination address block by first detecting the leading edge of the envelope. The second camera system begins storing an image of the destination address block when the block reaches the second camera, and stops storing the image when the block moves past the second camera. A postal code reader subsequently processes the high-resolution scan to read the postal code.

Another example is disclosed in *Morton et al.*, U.S. Patent No. 5,642,442. This patent describes a two-camera system that reads the destination addresses on parcels traveling on a conveyor. A fluorescent ink fiduciary mark is superimposed relative to the destination address on a parcel. A first camera captures an image of the fiduciary mark, the position and orientation of which is ascertained. The position and orientation of the fiduciary mark is then used to extract an image of the destination address from a video data signal created by a second camera, which is positioned downstream from the first camera. The image of the destination address is stored in a computer memory for subsequent processing by a character recognition system.

The two-camera systems described above are very effective at minimizing the amount of video data that must be stored in an OCR system. They are, however, rather expensive systems that are best suited for very high-speed parcel handling systems. The cost associated with these systems may not be justified for many lower-speed parcel handling systems. There is, therefore, a need for a less expensive system for minimizing the amount of video data that must be stored in an OCR system. In particular, there is a need for an inexpensive indicia reader system that is suited to low- to medium-speed parcel handling systems.

Summary of the Invention

The invention seeks to provide a low-cost system for minimizing the amount of video data that must be stored in an OCR system. In particular, the invention seeks to provide an inexpensive indicia reader system suited to low- to medium-speed parcel handling systems.

In accordance with the invention, these objects are accomplished in an indicia reader system that includes an optical guide to assist the positioning of parcels on a conveyor. For example, the optical guide may include a static elongated strip of light projected toward the conveyor from an illumination source positioned above the conveyor. An operator positions a parcel on the conveyor so that indicia to be imaged, such as the destination address on the parcel, is within static elongated strip of light. The parcel may also be positioned on the conveyor so that other indicia that is not to be imaged, such as the return address on the parcel, is not within the static elongated strip of light. Projecting the optical guide onto the parcel avoids parallax-related alignment errors that could otherwise occur with tall parcels in systems using other types of optical guides, such as reference marks placed on the conveyor itself.

The optically-guided indicia reader system may also include a proximity sensor, such as a photo detector, for detecting the arrival of the parcel at the scanner. In response to a signal from the proximity sensor, the computer memory and the scanner may be operated so as to store an image of a region having a width approximately equal to the width of the area defined by the illumination source, and a length approximately equal to the length of the parcel in the direction of conveyor travel.

The optically-guided indicia reader system may also include a reflectivity sensor located upstream of the scanner and positioned to determine reflectivity data associated with the parcel. A communication link transmits the reflectivity data from the reflectivity sensor to the scanner, and the gain of the scanner is adjusted in response to the reflectivity data. In addition, an optically-guided indicia reader system may include a height sensor located above the conveyor and upstream of the scanner and positioned to determine height data associated with the parcel at the location of the destination address. A communication link transmits the height data from the height sensor to the scanner, and the scanner is focused in response to the height data.

According to another aspect of the invention, an operator positions a parcel on the conveyor so that indicia to be imaged, such as the destination address on the parcel, coincides with a moving spot light defined by an illumination source. A scanner located downstream of the illumination source captures an image of a region that is defined with respect to the spot defined by the illumination source. For example, the optical guide may include a moving light, such as a narrow-beam spot light, that is projected onto the conveyor, and that travels at the same speed as the conveyor. Positioning a parcel on the conveyor so that the spot light is located in the center of the city and state address lines of the destination address allows a scanner to efficiently capture an image of the destination address for processing by a character recognition reader.

The moving-light indicia reader system includes a conveyor for transporting a parcel from an upstream location of the conveyor to a downstream location of the conveyor. A moving-light system, which is preferably positioned above the conveyor, includes an illumination source for defining a spot that moves at the same speed as the conveyor to assist in positioning the parcel on the conveyor. A scanner, which is located downstream from the moving-light illumination source, and a processing module are operated so as to store an image of a region of the parcel defined with respect to the spot defined by the moving-light illumination source. For example, the illumination source may define a spot that is substantially smaller than the region to be imaged by the scanner of the indicia reader system. An operator may then position a parcel so that the spot defined by the moving-light illumination source is located approximately in the center of the city and state lines of the destination address on the parcel.

A moving-light indicia reader system may also include a reflectivity sensor located upstream of the scanner and positioned to determine reflectivity data associated with the parcel. Reflectivity data from the reflectivity sensor is obtained for the spot defined by the moving-light illumination source so that reflectivity data is collected regarding the parcel at the region to be

captured and stored for subsequent processing by a character recognition system. A communication link transmits this reflectivity data from the reflectivity sensor to the scanner, and the gain of the scanner is adjusted in response to the reflectivity data. In addition, a moving-light indicia reader system may include a height sensor located above and upstream of the scanner and positioned to determine height data associated with the parcel at the location of the destination address. Height data from the height sensor is obtained for the spot defined by the moving-light illumination source so that height data is collected regarding the parcel at the region to be captured and stored for subsequent processing by the character recognition system. A communication link transmits this height data from the height sensor to the scanner, and the scanner is focused in response to the height data.

According to yet another aspect of the invention, a multi-conveyor indicia reader system includes a plurality of moving-light indicia reader systems, wherein each moving-light indicia reader system includes an illumination source for defining a spot that moves at the same speed as its respective conveyor to assist in positioning parcels on the conveyor. The processing module and the scanner of each moving-light indicia reader system are operated so as to store an image of a region of the parcel defined with respect to the spot defined by the illumination source. In addition, the illumination sources are operated so as to time-division multiplex the storage of the images generated by the several moving-light indicia reader systems.

That the present invention improves over the drawbacks of the prior art and accomplishes the objects of the invention will become apparent from the following detailed description of the preferred embodiment and the appended drawings and claims.

Brief Description of the Drawings

FIG. 1 is a diagram of an optically-guided indicia reader system.

FIG. 2, including FIGS. 2A-2E, illustrates a moving-light indicia reader system.

FIG. 3 illustrates a parcel with the spot defined by the moving-light system located approximately in the center of the city and state address lines of the destination address.

FIG. 4 illustrates a multi-conveyor indicia reader system.

Detailed Description

FIG. 1 is a diagram of an optically-guided indicia reader system **10** that includes a conveyer **12** carrying a parcel **14** from an upstream location **16** to a downstream location **18** of the conveyor **12**. The parcel **14** includes indicia to be read by the optically-guided indicia reader system **10**, such as a destination address **20**. The parcel **14** may include other indicia, such as the return address, that the indicia reader system **10** preferably avoids reading.

An illumination source **24** is positioned to define a static area **26** to assist in positioning the parcel **14** on the conveyor **12**. The area **26** is static in that it does not travel along with the conveyor **12**, but remains stationary with respect to an operator station that is located along side the conveyor **12**. Thus, the conveyor **12** travels through the area **26**, which is defined by light

projected by the illumination source **24**.

The illumination source **24** may define the area **26** many different ways. For example, illumination source **24** may illuminate the interior of area **26**, or the border of the area **26**, or two spaced-apart parallel lines in the direction of conveyor travel, etc. The illumination source **24** is positioned a sufficient distance above the conveyor **12** so that the parcel **14** may be positioned on the conveyor **12** to pass beneath the illumination source **24**. An operator may therefore view the area **26**, which is defined by light projected by the illumination source **24**, directly on the parcel **14** as the operator positions the parcel **14** on the conveyor **12**. The area **26** thus provides an optical guide to assist the operator in positioning the parcel **14** on the conveyor **12**.

A sensor assembly **28**, including a height sensor and reflectivity sensor, my be located toward the downstream end of the illumination source **24**. A communication link **30** functionally connects the sensor assembly **28** to a scanner **32** that is located downstream from the sensor assembly **28**. The scanner **32** is focused in response to height data from the height sensor, and the gain of the scanner **32** is adjusted in response to reflectivity data from the reflectivity sensor, so that the scanner **32** generates a clear image of the top of the parcel **14** as the parcel passes beneath the scanner **32**. The scanner **32** is preferably positioned so that the scan line **34** is oriented across a portion of the conveyor **12** that is aligned with the area **26** in the cross-machine direction.

A belt encoder **36** measures the displacement of the conveyor **12**. A communication link **38** functionally connects the belt encoder **36** to the scanner **32** and to a character recognition system **40** that includes a processing unit **41** and a computer memory **42**. Another communication link **44** functionally connects the character recognition system **40** to the scanner **32**. The height data from the sensor assembly **28** indicates the presence of a parcel **14** on a particular location of the conveyor **12**. Thus, the height data and the signal from the belt encoder **36** may be used to determine when a parcel **14** is present at the scanner **32**.

Alternatively, a proximity sensor, such as a photo sensor **45**, may be positioned upstream from the scanner **32**. A communication link **48** functionally connects the scanner **32** to the photo sensor **45**. The photo sensor includes a light source **46a** that projects a columnar beam of light **50** toward a photo detector **46b**. The photo sensor **45** detects the presence of the parcel **14** as it passes by the photo sensor **45** because the parcel breaks the beam of light **50**. Many other types of proximity sensors, such as a mechanical or a magnetic sensor, may equivalently be used to detect the location of the parcel **14** on the conveyor **12**.

The belt encoder **36** is a standard belt-driven, opto-mechanical encoder that provides a signal indicating the linear displacement of the conveyor **12**. The CCD array of the scanner **32** is cycled in response to the signal from the belt encoder **26** to generate a series of analog images of the scan line **34** that are transmitted to an analog-to-digital converter within the scanner **32**. The analog-to-digital converter of the scanner **32** uses a standard thresholding or similar process to convert the analog signal produced by the CCD array of the scanner **32** into an eight-bit digital

video signal that is transmitted via the communication link **44** to the character recognition system **40**, which stores the video data in the computer memory **42** for subsequent processing.

The region to be stored in the computer memory **42** may include all or part of the scan line **34**. This may be accomplished by only storing the output of all or only a portion of the cells of the scanner **32**. The region to be stored in the computer memory **42** is preferably aligned with and has a length that is approximately equal to the width of the area **26** so that the region stored in the computer memory **42** corresponds to, but is downstream from, the area **26** defined by the illumination source **24**. This assists an operator in orienting a parcel **14** so that the destination address **20** can be effectively scanned by the indicia reader system **10** as configured. Alternatively, the operator may determine that the parcel **14** cannot be oriented so that the destination address **20** can be effectively scanned by the indicia reader system **10** as configured. This may happen if the destination address **20** is larger than the region to be stored in the computer memory **42**. In this case, the operator can divert the parcel **14** for hand sorting or imaging using a differently configured indicia reader system.

The scanner **32** may run continuously, so that region generated by the scanner **32** and stored in the computer memory **42** of the character recognition system **40** is a continuous strip having a width approximately equal to the width of the area **26** defined by the illumination source **24**. The size of the region may be further reduced by using the height data from the sensor assembly **28** or the signal from the photo sensor **45** to trigger the storage of video data generated by the scanner **32**. For example, the video data generated by the scanner **32** may be stored in the computer memory **42** only when the beam **50** of the photo sensor **45** is broken. A time delay may be imposed to account for the distance between the beam **50** or the sensor assembly **28** and the scan line **34**. In this manner, an image of a strip of the top of the parcel **14** including the destination address **20** may be stored in the computer memory **42**. That is, an image of a region of the parcel **14** having a width approximately equal to the width of the area **26** defined by the illumination source **24**, and a length approximately equal to the length of the parcel **14** in the direction of conveyor travel, may be stored in the computer memory **42** of the character recognition system **40**.

Triggering the storage of the image of the region in the computer memory **42** may be accomplished in several different ways. For example, the scanner **32** may be toggled on and off by the signal from the photo sensor **45** or the sensor assembly **28** (with an appropriate time delay). Or the scanner **32** may run continuously, and the signal from the photo sensor **45** or the sensor assembly **28** may be used to latch a control line to an input buffer of the character recognition system **40**. Alternatively, the signal from the photo sensor **25** or the sensor assembly **28** may be used as an input to a software-based algorithm running on the processing unit **41**, which triggers the storage of video data from the scanner **32** in the computer memory **42**. Many other means known to those skilled in the art may equivalently be employed to operate the computer memory **42** and the scanner **32** so as to store an image of a region in the computer memory **42**.

To use the static-light indicia reader system **10**, an operator positions the parcel **14** on the conveyor **12** so that the destination address **20** is within the area **26** defined by the illumination source **24**. The operator may also position the parcel **14** on the conveyor **12** so that other indicia on the parcel **14**, such as the return address **22**, is not within the area **26** defined by the illumination source **24**. It will be appreciated that many other types of indicia may be placed within, or excluded from, the area **26**, such a barcode, a two-dimensional code, a hologram, etc.

Acceptable performance is experienced when optically-light indicia reader system **10** is configured as follows. The area **26** is typically a rectangular strip that is significantly narrower than the conveyor **12**, sufficiently long to allow an operator to easily position a parcel on the conveyor **12** using the optical guide, and approximately in the center of the conveyor **12**. For example, the area **26** may be approximately 4 inches (10 cm) in the cross-machine direction and approximately 12 (30 cm) to 36 inches (91 cm) in the direction of conveyor travel. The use of projected illumination, rather than an area painted on the conveyor **12**, allows the operator to view the area **26** defined by the illumination source **24** directly on the top of the parcel **14**. Thus, there is no displacement between the area **26** and the top of the parcel **14** that could cause parallax-related alignment errors with tall parcels. The use of a relatively narrow area **26** allows the angle of the field of view of the scanner **32** to be relatively narrow so that the scanner **32** generates a sharp image of the top of the parcel **14**.

The belt encoder **36** is a standard belt-driven, opto-mechanical encoder that provides a signal indicating the linear displacement of the conveyor **12**. The CCD array of the scanner **32** is cycled in response to the signal from the belt encoder **36** to generate a series of analog images of the scan line **34** that are transmitted to an analog-to-digital converter within the scanner **32**. The analog-to-digital converter of the scanner **32** uses a standard thresholding or similar process to convert the analog signal produced by the CCD array of the scanner **32** into an eight-bit digital video signal that is transmitted via the communication link **44** to the character recognition system **40**, which is operable for storing the video data in the computer memory **42** for subsequent processing.

The scanner **32** is preferably a monochrome, 4,096 pixel line-scan type CCD array such as one using a Thompson TH7833A CCD chip. As the field of view of the scanner **32** is approximately 16 inches (41 cm) at the conveyor **12**, the resolution of the image created by the scanner **32** is approximately 256 pixels or "dots" per inch (DPI) (101 dots per cm) across the field of view of the scanner **32**. The belt encoder **36** preferably triggers the CCD array of the scanner **32** at a rate of approximately 256 cycles per inch (101 cycles per cm) so that the resolution of the image created by the scanner **32** is approximately 256 pixels or "dots" per inch (DPI) (101 dots per cm) in the direction of conveyor travel. It will therefore be appreciated that a digital image with a correct aspect ratio (i.e., the ratio of the length of the image to the width) may be generated by the scanner **32** and stored in the computer memory **42** of the character recognition system **40** by synchronizing the cycling rate of the scanner **32** with the linear speed

of the conveyor **12**. See, for example, *Shah et al.*, U.S. Patent No. 5,291,564, which is incorporated by reference.

The conveyor **12** may be approximately 24 inches (61 cm) wide and travel at linear speeds up to 20 inches per second or 100 feet per minute (51 cm per second or 30 meters per minute) or more. The illumination source **24**, which may be any of a variety of commercially-available narrow-beam light sources, is preferably positioned approximately 18 inches (46 cm) above conveyor **12** and defines an area **26** that is approximately 4 inches (10 cm) in the cross-machine direction and approximately 12 (30 cm) to 36 inches (91 cm) in the direction of conveyor travel.

The scanner **32** is preferably mounted to have an optical path of approximately 120 inches (304 cm) to the conveyor **12** with a 16 inch (41 cm) field of view at the conveyor **12**. To save space, the scanner **32** is positioned approximately 30 inches (76 cm) above the center of conveyer **12** and is pointed towards a complex of mirrors (not shown) that increases the optical path from the scanner **32** to the conveyor **12** to approximately 120 inches (305 cm). These parameters may be varied somewhat without unduly affecting the performance of the disclosed embodiment of the present invention. See also, *Smith et al.*, U.S. Patent No. 5,308,960, and *Bjorner, et al.*, U.S. Patent No. 5,485,263, which are incorporated by reference.

It should also be understood that the scan line **34** may be longer than the width of the region stored in the computer memory **42**. For example, the scanner **32** may be positioned to have a field of view (i.e. the scan line **34**) equal to approximately 16 inches (41 cm) at the conveyor **12**. The region stored in the computer memory **42**, however, may only be approximately 4 inches (10 cm), which preferably corresponds to the width of the area **26** defined by the illumination source **24**. This may be accomplished by only storing the output of a portion of the cells of the scanner **32** (e.g., the center 1,024 pixels of a 4,096 pixel scanner) in the computer memory **42**.

In view of the forgoing, it will be appreciated that the optically-guided indicia reader system **10** reduces the amount of video data that must be stored in the computer memory **42** of the character recognition system **40**. The use of projected illumination allows the operator to view the area **30** defined by the illumination source **24** directly on the top of the parcel **14**. Thus, there is no displacement between the area **26** and the top of the parcel **14** that could cause parallax-related alignment errors with tall parcels. In addition, the optically-guided indicia reader system **10** allows the angle of the field of view of the scanner **32** to be relatively narrow so that the scanner **32** generates a sharp image of the top of the parcel **14**.

FIGS. 2A-2E illustrate another embodiment of the invention, a single-conveyor moving-light indicia reader system in which a moving-light illumination source defines a spot that moves at the same speed as a conveyor to assist the positioning of a parcel on the conveyor. FIG. 3 illustrates a parcel in this moving-light indicia reader system with the spot defined by the moving-light illumination source located approximately in the center of the region to be captured. More specifically, the parcel is preferably positioned on the conveyor so that the center of the

spot defined by the moving-light illumination source is approximately in the center of the city and state lines of the destination address. FIG. 4 illustrates a multi-conveyor indicia reader system, in which the illumination sources of a plurality of moving-light indicia reader systems are operated so as to time-division multiplex the storage of the images generated by the several moving-light indicia reader systems. These embodiments of the invention are described below.

FIGS. 2A-E illustrate a moving-light indicia reader system **200** including a conveyer **212** carrying a parcel **214** from an upstream location **216** to a downstream location **218** of the conveyor **212**. The parcel **214** includes indicia to be read by the moving-light indicia reader system **200**, such as a destination address **220**. The parcel **214** may include other indicia, such as the return address, that the moving-light indicia reader system **200** preferably avoids reading.

The moving-light indicia reader system **200** includes a moving-light illumination source **224** that includes a plurality of discrete illumination sources **226a** through **226n**, such as light-emitting diodes (LEDs), that project columnar beams of light represented by the beam **228**. The illumination source **224** is positioned a sufficient distance above the conveyor **212** so that the parcel **214** may be positioned on the conveyor **212** to pass beneath the moving-light illumination source **224**. An operator may therefore view the spot **230**, which is defined by light projected by the moving-light illumination source **224**, directly on the parcel **214** as the operator positions the parcel **214** on the conveyor **212**. The spot **230** thus provides an optical guide to assist the operator in positioning the parcel **214** on the conveyor **212**.

A sensor assembly **232**, including a height sensor and reflectivity sensor, is located toward the downstream end of the illumination source **224**. A communication link **234** functionally connects the sensor assembly **232** to a scanner **236** that is located downstream from the sensor assembly **232**. The scanner **236** includes internal components **233** well known to those skilled in the art to automatically focus the scanner **236** in response to height data from the height sensor, and to automatically adjust the gain of the scanner **236** in response to reflectivity data from the reflectivity sensor, so that the scanner **236** generates a clear image of the top of the parcel **214** at the region to be captured and stored for subsequent processing by a character recognition system **240** as the parcel **244** passes beneath the scanner **236**. The scanner **236** is aligned with the spot **230** so that the scanner may be operated to capture an image of the destination address **220** on the parcel **214**.

A belt encoder **238** measures the displacement of the conveyor **212**. A communication link **240** functionally connects the belt encoder **238** to the scanner **236** and to a character recognition system **240** that includes a processing module **241** and a computer memory **242**. A second communication link **244** functionally connects the character recognition system **240** to the scanner **236**, and a third communication link **246** functionally connects the character recognition system **240** to the moving-light illumination source **224**. The signal from the belt encoder **238** is used to determine the speed of the conveyor **212**, which is used to synchronize the operation of the moving-light illumination source **224**, the scanner **236**, and the character recognition system **240** so that an image of a region **250** defined with respect to the spot **230** is

stored in the computer memory 242. The height data from the sensor assembly 232 indicates the presence of a parcel 214 in association with a spot 230 so that an image of a region 250 is only stored in the computer memory 242 when a parcel 214 is present in association with a spot 230 defined by the moving-light illumination source 224.

To use the moving-light indicia reader system 200, an operator positions the parcel 214 on the conveyor 212 so that the spot 230 defined by the moving-light illumination source 224 is centered with respect to the destination address 220 on the parcel 214. For example, FIG. 2A illustrates the parcel 214 positioned so that the spot 230 defined by the first discrete illumination source 226a is centered with respect to the destination address 220. From this position, the parcel 214 travels on the conveyor 212, and the spot 230 travels at the same speed as the parcel 214, so that the spot 230 remains stationary relative to the parcel 214. Thus, as illustrated in FIG. 2B, the parcel 214 is later positioned so that the spot 230' defined by the third discrete illumination source 226c is centered with respect to the destination address 220. Later still, as illustrated in FIG. 2C, the parcel 214 is positioned so that the spot 230'' defined by the last discrete illumination source 226n is centered with respect to the destination address 220.

FIGS. 2D and 2E illustrate the scanning of the parcel 214 by the scanner 236, which includes a CCD array that repeatedly generates an image of a scan line 252 to generate a video signal. The operation of the scanner 236 and the processing module 241 of the character recognition system 240 are synchronized with the movement of the spot 230 so as to store in the computer memory 242 an image of the region 250, which is defined with respect to the spot 230. When the region 250 reaches the scan line 252, which happens shortly after the parcel 214 is in the position shown in FIG. 2D, the processing module 241 causes the computer memory 242 of the character recognition system 240 to begin storing the video data generated by the scanner 236. The video data generated by the scanner 236 continues to be stored until the region 250 passes the scan line 252, which happens shortly before the parcel 214 is in the position shown in FIG. 2E.

It will be understood that, when the parcel 214 is positioned as shown in FIGS. 2D-E, the spot 230 is not visible to an operator because the parcel 214 is not under the moving-light illumination source 224. Nevertheless, the character recognition system 240 uses the signal from the belt encoder 238 to keep track of the spot 230 after the parcel 214 travels past the moving-light illumination source 224. Thus, an image of the region 250, which is defined with respect to the spot 230, is stored in the computer memory 242 of the character recognition system 240.

FIG. 3 illustrates a parcel 214 with the spot 230 defined by the moving-light illumination source 224. The spot 230 is typically a round or oval area that is somewhat smaller that than the region 250 to be imaged by the scanner 236. For example, the area associated with the spot 230 may be approximately one 1 inch (2.5 cm) across, whereas the region 250 may be approximately 4 inches (10 cm) by 4 inches (10 cm). The parcel 214 is

preferably positioned so that the center of the spot **230** is approximately in the center of the city and state address lines of the destination address **220**. This allows the scanner **236** to capture an image of the destination address **220** by imaging the region **250**.

It will be appreciated, however, that the spot **230** may have virtually any size or configuration, and that multiple spots may be used to identify indicia on the parcel, such as four spots defining the corners of a rectangular region to be imaged. For example, the spot **230** may be defined by an illuminated area, or by an illuminated border, or by two illuminated spaced-apart parallel lines, etc. In addition, the spot **230** could be configured to correspond to the width of the region **250** to be stored in the computer memory **224**. This would assist an operator in orienting a parcel **214** so that the destination address **220** can be effectively scanned by the indicia reader system **200** as configured. Alternatively, the operator may determine that the parcel **214** cannot be oriented so that the destination address **220** can be effectively scanned by the indicia reader system **200** as configured. This may happen if the destination address **220** is larger than the region **250** to be stored in the computer memory **242**. In this case, the operator can divert the parcel **214** for hand sorting or imaging using a differently configured indicia reader system.

To capture the image of the region **250**, the character recognition system **240** is operative to selectively trigger the storage of an image in the computer memory **242**. Triggering the storage of the image of the region **250** in the computer memory **242** may be accomplished in several different ways. For example, the scanner **236** may be toggled on and off by the processing module **241** in response to the signal from the belt encoder **238**. Or the scanner **236** may run continuously, and the processing module **241** may respond to the signal from the belt encoder **238** by latching a control line to an input buffer of the character recognition system **240**. Alternatively, the signal from the belt encoder **238** may be used as an input to a software-based algorithm running on the processing module **241**, which triggers the storage of video data from the scanner **236** in the computer memory **242**. Many other means known to those skilled in the art may equivalently be employed to operate the character recognition system **240** and the scanner **236** so as to store an image of the region **250** in the computer memory **242**.

Acceptable performance is experienced when moving-light indicia reader system **200** is configured as follows. The belt encoder **238** is a standard belt-driven, opto-mechanical encoder that provides a signal indicating the linear displacement of the conveyor **212**. The CCD array of the scanner **236** is cycled in response to the signal from the belt encoder **238** to generate a series of analog images of the scan line **252** that are transmitted to an analog-to-digital converter within the scanner **236**. The analog-to-digital converter of the scanner **236** uses a standard thresholding or similar process to convert the analog signal produced by the CCD array of the scanner **236** into an eight-bit digital video signal that is transmitted via the communication link **246** to the character recognition system **240**, which is operable for storing the video data in the computer memory **242** for subsequent processing.

The scanner **236** is preferably a monochrome, 4,096 pixel line-scan type CCD array

such as one using a Thompson TH7833A CCD chip. As the field of view of the scanner **236** is approximately 16 inches (41 cm) at the conveyor **212**, the resolution of the image created by the scanner **232** is approximately 256 pixels or "dots" per inch (DPI) (101 dots per cm) across the field of view of the scanner **236**. The belt encoder **238** preferably triggers the CCD array of the scanner **236** at a rate of approximately 256 cycles per inch (2.54 cm) so that the resolution of the image created by the scanner **232** is approximately 256 pixels or "dots" per inch (DPI) (101 dots per cm) in the direction of conveyor travel. It will therefore be appreciated that a digital image with a correct aspect ratio (i.e., the ratio of the length of the image to the width) may be generated by the scanner **236** and stored in the computer memory **242** of the character recognition system **240** by synchronizing the cycling rate of the scanner **236** with the linear speed of the conveyor **212**.

The conveyor **212** may be approximately 24 inches (61 cm) wide and travel at linear speeds up to 20 inches per second or 100 feet per minute (51 cm per second or 30 meters per minute) or more. The moving-light illumination source **224** is preferably positioned approximately 18 inches (46 cm) above conveyor **212** and defines a spot **230** that is approximately 1 inch (2.5 cm) wide and 1 inch (2.5 cm) long at the conveyor **212**. The moving-light illumination source **224** may be operated so that successive moving spots **230** are spaced virtually any distance apart. For example, acceptable performance is experienced when the moving-light indicia reader system **200** is operated with the conveyor **212** traveling at 50 feet per minute (25 cm per second or 15 meters per minute), and with the moving spots **230** spaced 22 inches (56 cm) apart, which allows the moving-light indicia reader system **200** to handle approximately 1,636 parcels per hour if the operator places a parcel under each moving spot.

The scanner **236** is preferably mounted to have an optical path of approximately 120 inches (305 cm) to the conveyor **212**, with a 16 inch (41 cm) field of view at the conveyor **212**. To save space, the scanner **236** is positioned approximately 30 inches (76 cm) above the center of conveyer **212** and is pointed towards a complex of mirrors (not shown) that increases the optical path from the scanner **236** to the conveyor **212** to approximately 120 inches (305 cm). These parameters may be varied somewhat without unduly affecting the performance of the disclosed embodiment of the present invention.

It should also be understood that the scan line **234** may be longer than the width of the region stored in the computer memory **242**. For example, the scanner **232** may be positioned to have a field of view (i.e., the scan line **234**) equal to approximately 16 inches (41 cm) at the conveyor **212**. The region stored in the computer memory **242**, however, may only be approximately 4 inches (10 cm) wide. This may be accomplished by only storing the output of a portion of the cells of the scanner **232** (e.g., the center 1,024 pixels of a 4,096 pixel scanner) in the computer memory **242**.

It will be appreciated that the moving-light illumination source **224** should be long enough to allow an operator to position the parcel **214** on the conveyor **212** while the spot **230**

travels from the upstream end to the downstream end of the moving-light illumination source **224**. For example, a moving-light illumination source **224** having a length of 36 inches (91 cm) and 72 LEDs spaced 1/2 inch (1.3 cm) apart is appropriate for the conveyor **212** traveling at 10 inches per second or 50 feet per minute (25 cm per second or 15 meters per minute), as described above. The LEDs **226a-n** of the moving-light illumination source **224** may be any of a variety of commercially available LEDs, such as a model AND190W0P manufactured by AND. The sensor assembly **232** may include any of a variety of commercially available height sensors, such as a model NR-40 manufactured by Innova Labs, Inc.

FIG. 4 is a diagram of a multi-conveyor indicia reader system **400** that includes a plurality of moving-light indicia reader systems **210a** through **210n**, which are virtually identical to those described above with respect to FIGS. 2A-E. Each of the moving-light indicia reader systems **210a** through **210n** are synchronized by, and provide their video data to, a single character recognition system **240**. The character recognition system **240** synchronizes the moving spots **230a** through **230n** of the moving-light indicia reader systems **210a** through **210n** so as to time-division multiplex the storage of the regions **250a** through **250n** from the several scanners **236a** through **236n**. In other words, the spots **230a** through **230n** are spaced relative to each other so that only one of the regions **250a** through **250n** captured by the scanners **236a** through **236n** needs to be stored in the computer memory **242** of the character recognition system **240** at any time. This allows the single character recognition system **240** to store the images generated by several moving-light indicia reader systems **210a** through **210n**, as shown in FIG. 4.

In view of the forgoing, it will be appreciated that the moving-light indicia reader system **400** allows the video data stored in the computer memory **242** of the character recognition system **240** to be reduced to a standard-sized region that is only large enough to capture the text of the destination addresses **220a-220n** on the various parcels carried on the conveyors **212a-212n**. The use of projected illumination allows the operator to view the spot **230a-230n** defined by each moving-light illumination source **224a-224n** directly on the top of the parcels **214a-214n**. Thus, there is no displacement between each spot **230a-230n** and the top of each parcel **214a-214n** that could cause parallax-related alignment errors with tall parcels. In addition, the moving-light indicia reader system **400** allows the angle of the field of view of the scanners **236a-236n** to be relatively narrow so that the scanners generates sharp images of the top of the parcels **214a-214n**.

It should be understood that the foregoing relates only to specific embodiments of the present invention, and that numerous changes may be made therein without departing from the spirit and scope of the invention as defined by the following claims.

CLAIMS

What is claimed is:

1. An optically-guided indicia reader system (10, 200) comprising a conveyor (12, 212) for transporting a parcel (14, 214) from an upstream location (16, 216) of the conveyor to a downstream location (18, 218) of the conveyor CHARACTERISED BY;

an illumination source (24, 224) positioned to define an area (26, 230) to assist in positioning the parcel (14, 214) on the conveyor (12, 212);

a scanner (32, 236) located downstream of the illumination source (24, 224);

a computer memory (42, 242) for storing the image; and

means (41, 241) for operating the scanner (32, 236) and the computer memory (42, 242) so as to capture an image of a region (250) defined with respect to the area (26, 230).

2. The optically-guided indicia reader system (10, 200) of Claim 1, further comprising:

a height sensor (28, 232) located upstream of the scanner (32, 236) and positioned to determine height data associated with the parcel (14, 212);

a communication link (30, 234) for transmitting the height data from the height sensor (28, 232) to the scanner (32, 236); and

means (33, 233) for focusing the scanner (32, 236) in response to the height data.

3. The optically-guided indicia reader system (10, 200) of Claim 1, further comprising:

a reflectivity sensor (28, 232) located upstream of the scanner (32, 236) and positioned to determine reflectivity data associated with the parcel (14, 214);

a communication link (30, 234) for transmitting the reflectivity data from the reflectivity sensor (28, 232) to the scanner (32, 236); and

means (33, 233) for adjusting the gain of the scanner (32, 236) in response to the reflectivity data.

4. The optically-guided indicia reader system (10) of Claim 1, wherein:

the area comprises a static elongate strip (26) having a width that is narrower than the conveyor (14); and

the region has a width approximately equal to the width of the static elongate strip (26).

5. The optically-guided indicia reader system (10) of Claim 1, further comprising:

means (41, 241) for operating the computer memory (42) and the scanner (32) so as to store an image of a region having a width approximately equal to the width of the area (26).

6. The optically-guided indicia reader system (10) of Claim 1, further comprising:

a proximity sensor (46) for detecting the presence of the parcel (14) at a predefined position (50) along the conveyor (12); and

a communication link (48) between the proximity sensor (46) and the scanner (32); and

means (36, 41) for, in response to the proximity data, operating the computer memory (42) and the scanner (32) so as to store an image of a region having a width approximately equal to the width of the area (26) and a length approximately equal to the length of the parcel (14) in the direction of conveyor travel.

7. The optically-guided indicia reader system (200) of Claim 6, wherein:

the area comprises a spot (230) that moves at the same speed as the conveyor (212) to assist in positioning the parcel (214) on the conveyor (212).

8. The optically-guided indicia reader system (200) of Claim 6, wherein the spot (230) is significantly smaller that the region (250).

9. A multi-conveyor indicia reader system (400) comprising a plurality of a conveyors (212), each for transporting parcels (214) from an upstream location (216) of the conveyor to a downstream location (216) of the conveyor CHARACTERISED BY:

a plurality of moving-light indicia reader systems (210), wherein each moving-light indicia reader system comprises,

an illumination source (224) for defining a spot (230) that moves at the same speed as the conveyor (212) to assist in positioning the parcel (214) on the conveyor (212), and

a scanner (236) located downstream of the illumination source (224) and positioned to capture an image of the parcel (214);

a computer memory (242) for storing the images; and

means (241) for operating the computer memory (214) and the scanner (236) of each moving-light indicia reader system (210a - 210n) and so as to store an image of a region (250) of the parcel (214) defined with respect to the spot (230) defined by the illumination source.

10. The multi-conveyor indicia reader system of Claim 9, wherein the illumination sources (224a - 224n) are operated so as to time-division multiplex the storage of the images generated by the plurality of moving-light indicia reader systems (210a - 210n).

11. The multi-conveyor indicia reader system of Claim 9, wherein each moving-light indicia reader system (210) further comprises:

a height sensor (232) located upstream of the scanner (236) and positioned to determine height data associated with the parcel (214) at the location of the spot (230);

a communication link (234) for transmitting the height data from the height sensor (232) to the scanner (236); and

means (233) for focusing the scanner (236) in response to the height data.

12. The multi-conveyor indicia reader system (400) of Claim 10, wherein each moving-light indicia reader system (210) further comprises:

a reflectivity sensor (232) located upstream of the scanner (236) and positioned to determine reflectivity data associated with the parcel (214) at the location of the spot (230);

a communication link (234) for transmitting the reflectivity data from the reflectivity sensor (232) to the scanner (236); and

means (233) for adjusting the gain of the scanner (236) in response to the reflectivity data.

13. A method for obtaining an image of indicia on a parcel (14, 214), comprising the step of providing a conveyor (12, 212) for transporting a parcel from an upstream location (16, 216) of the conveyor to a downstream location (18, 218) of the conveyor (12, 212), CHARACTERISED BY THE STEPS OF;

providing an illumination source (24, 224) positioned to define an area (26, 230) to assist in positioning the parcel (14, 214) on the conveyor (12, 212);

positioning the parcel (14, 214) so that the indicia (20, 220) is within the area (26, 230) defined by the illumination source (24, 224);

operating a scanner (32, 236) to capture an image of a region (250) defined with respect to the area (26, 230) to obtain an image of the indicia (20, 220); and

storing the image in a computer memory (42, 242).

14. The method of Claim 13, further comprising the steps of:

generating height data associated with the parcel (14, 214); and

focusing the scanner (32, 236) in response to the height data.

15. The method of Claim 13, further comprising the steps of:

generating reflectivity data associated with the parcel (14, 214); and

adjusting the gain of the scanner (32, 236) in response to the reflectivity data.

16. The method of Claim 13, wherein:

the area comprises an elongate strip (26) having a width that is narrower than the conveyor (12); and

the region has a width approximately equal to the width of the elongate strip (26).

17. The method of Claim 13, further comprising the steps of:

operating a computer memory (42) and the scanner (32) so as to store an image of a region having a width approximately equal to the width of the area (26).

18. The method of Claim 13, further comprising the steps of:

generating proximity data associated with the parcel (14); and

in response to the proximity data, operating a computer memory (42) and the scanner (32) so as to store an image of a region having a width approximately equal to the width of the area (26) and a length approximately equal to the length of the parcel (14) in the direction of conveyor travel.

19. The method of Claim 13, wherein :

the step of illuminating the area to assist in positioning the parcel (214) on the conveyor (212) comprises the step of illuminating a spot (230) that moves at the same speed as the conveyor (212).

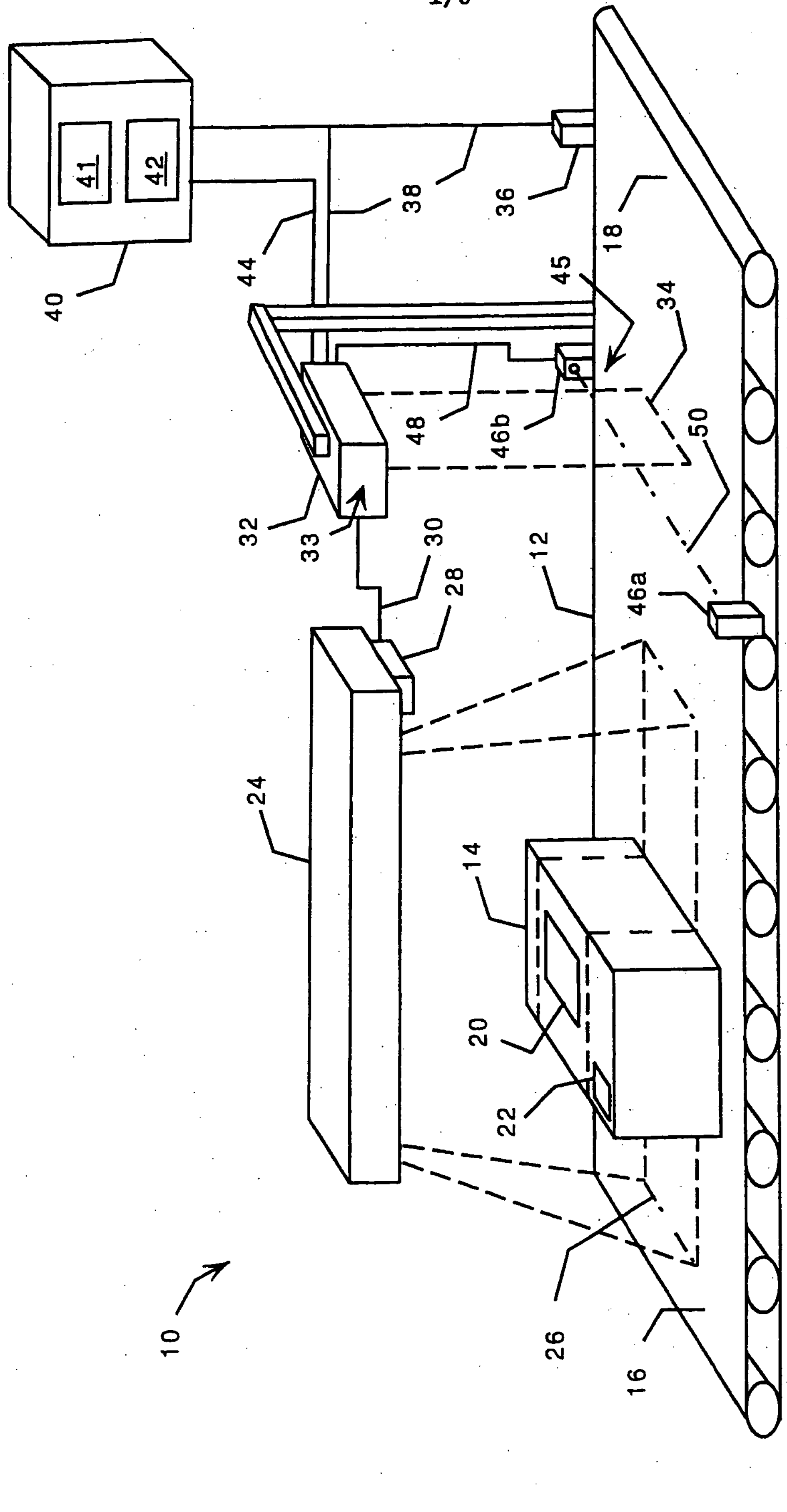
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FIG. 1

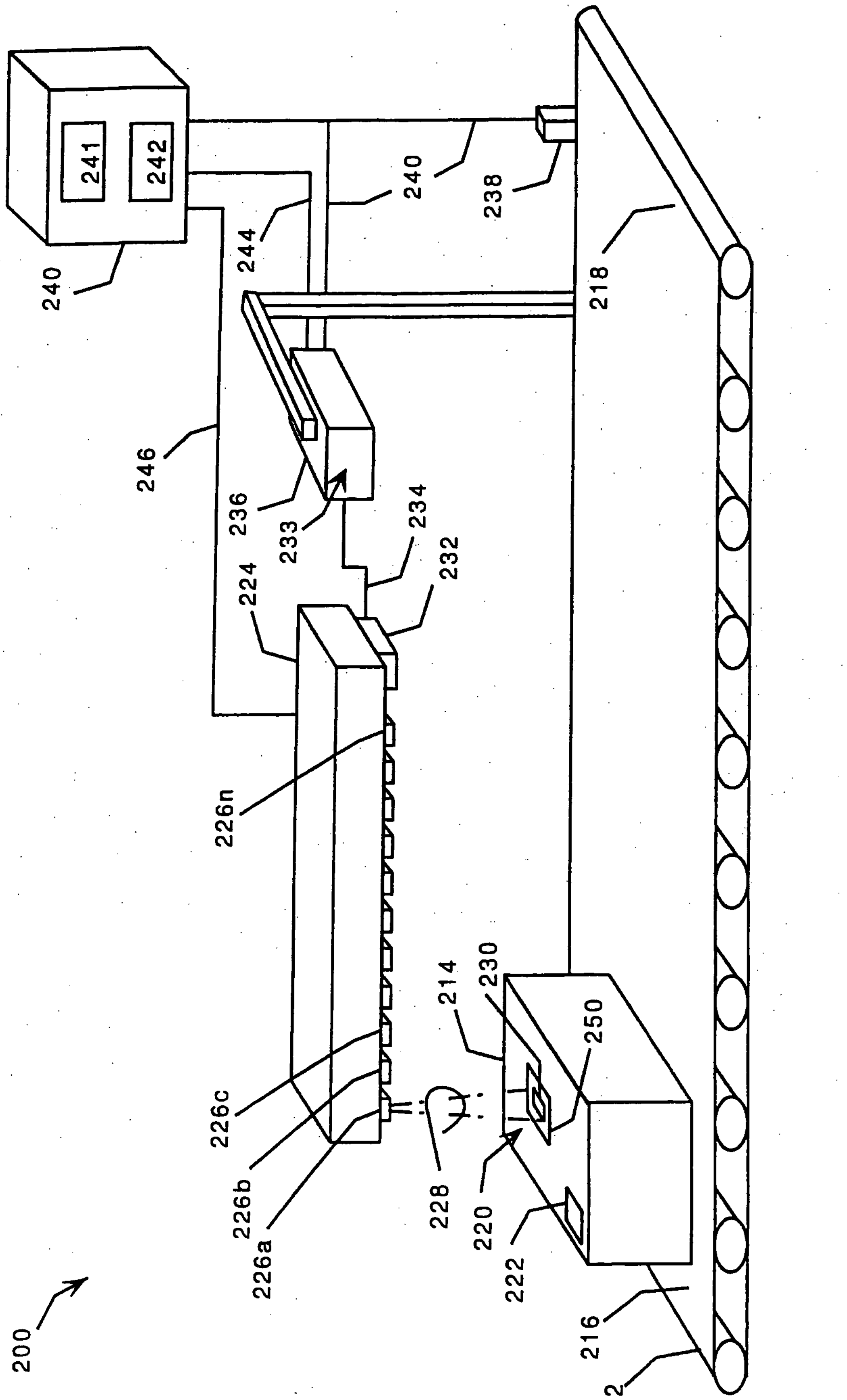
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FIG. 2A

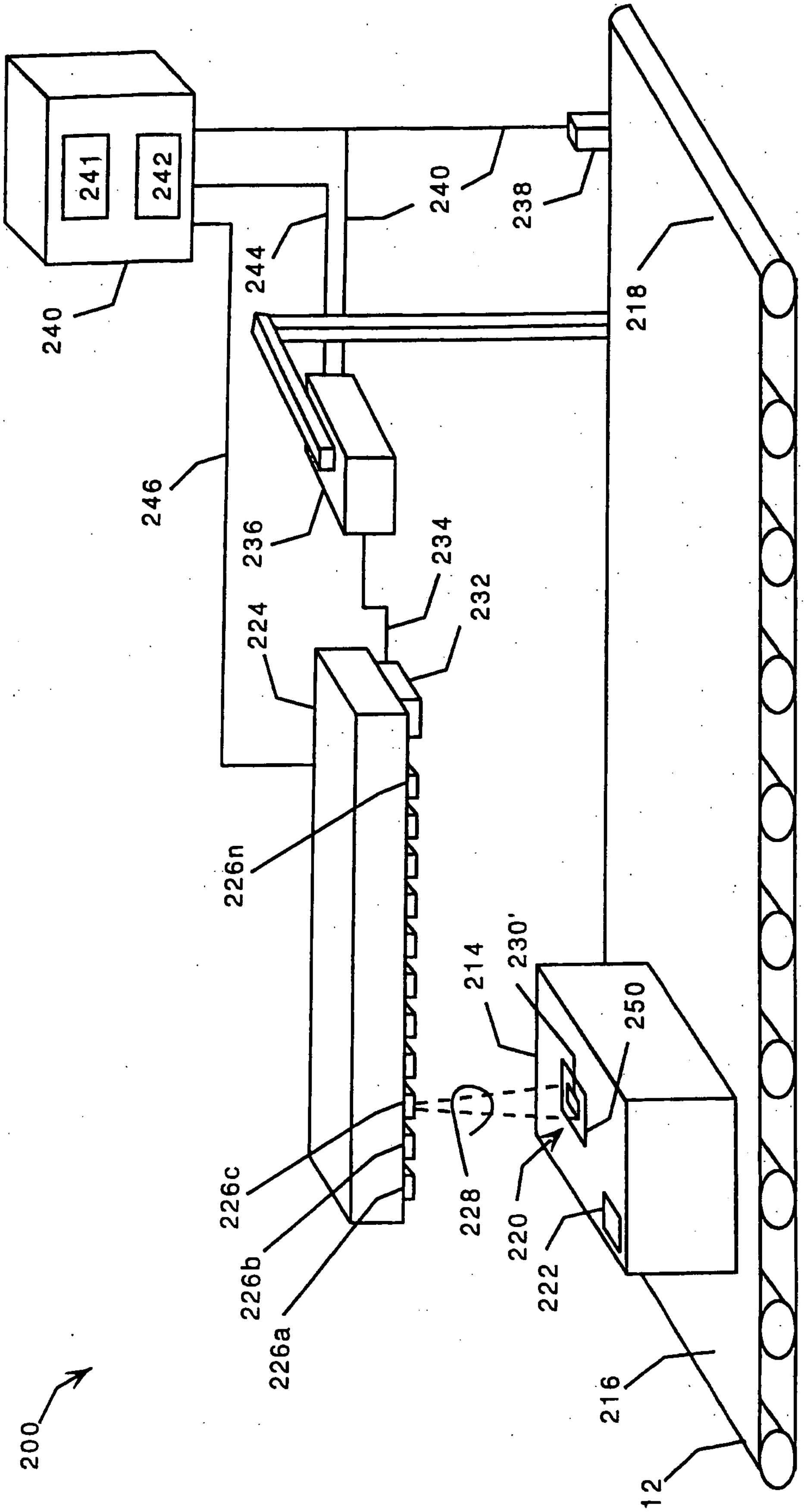
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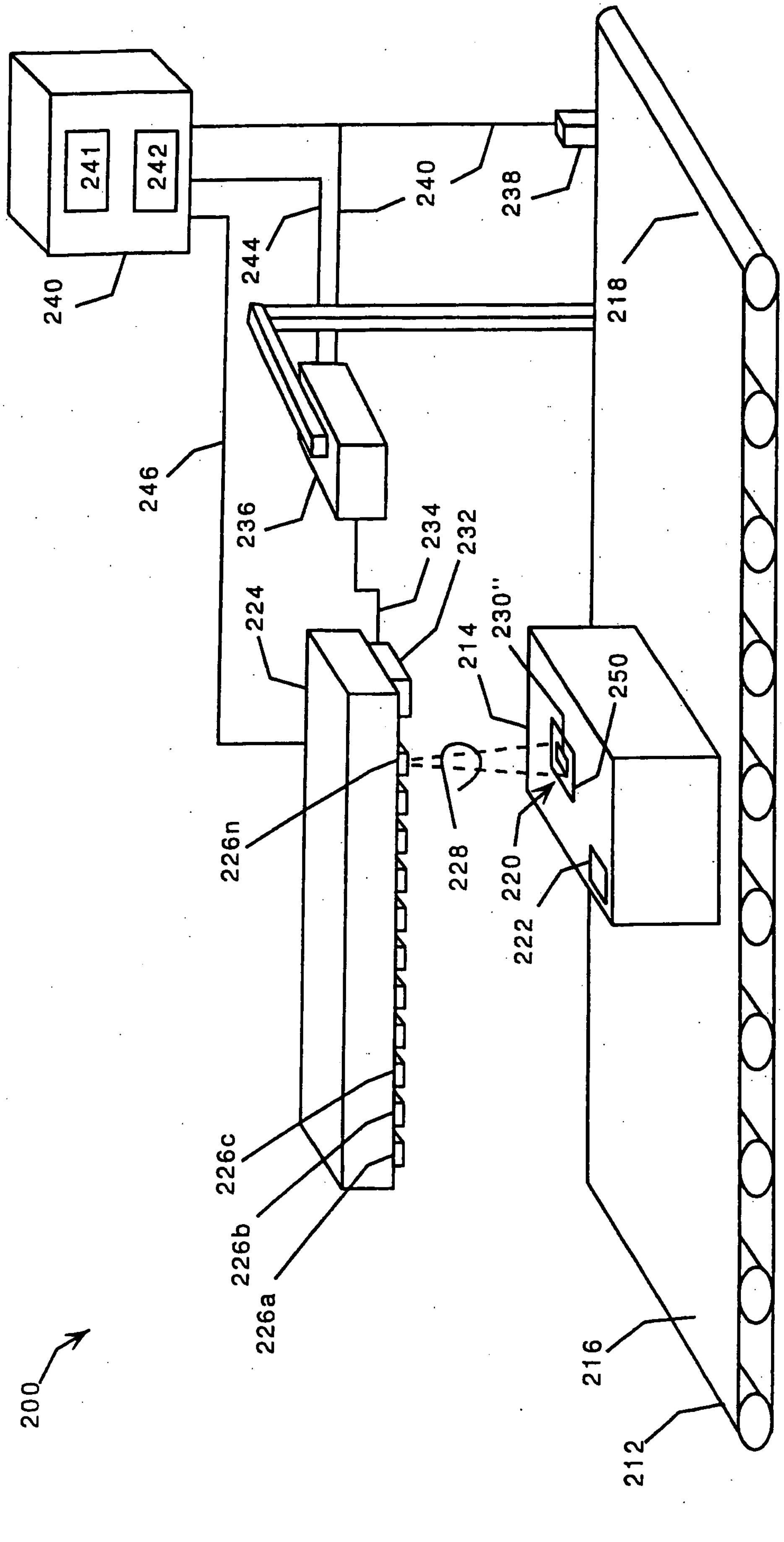
FIG. 2B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224
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FIG. 2C

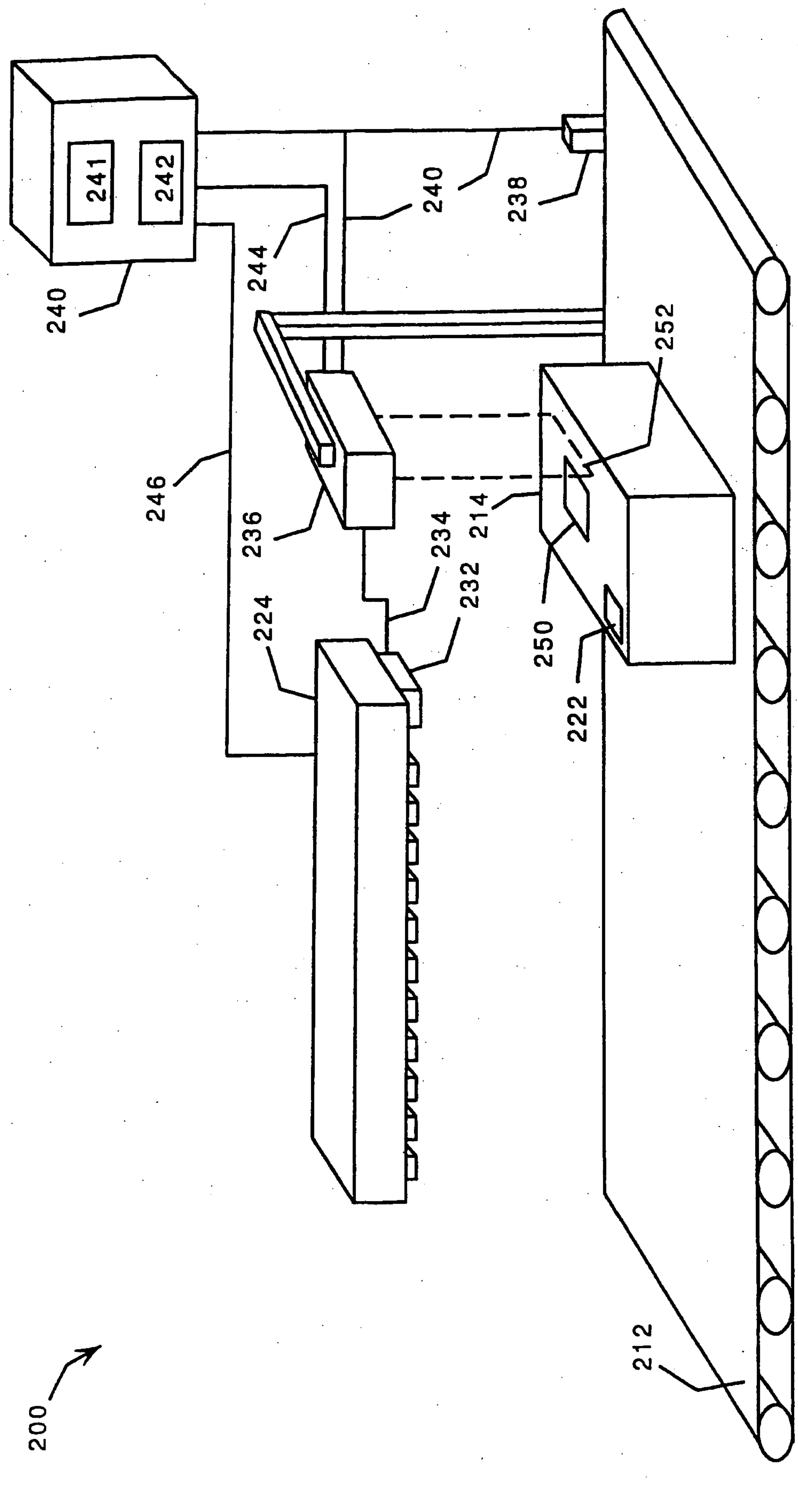
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FIG. 2D

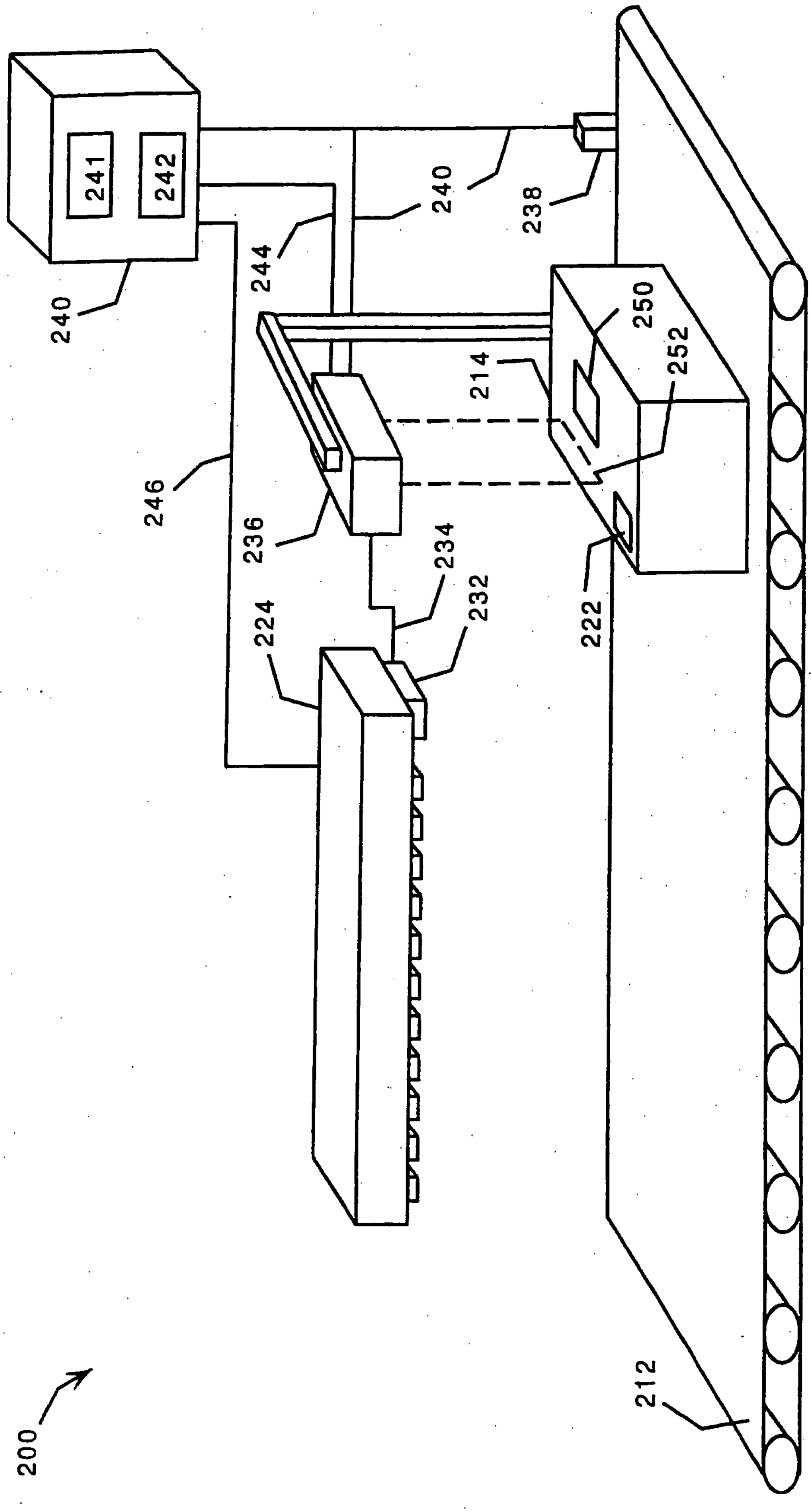
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FIG. 2E

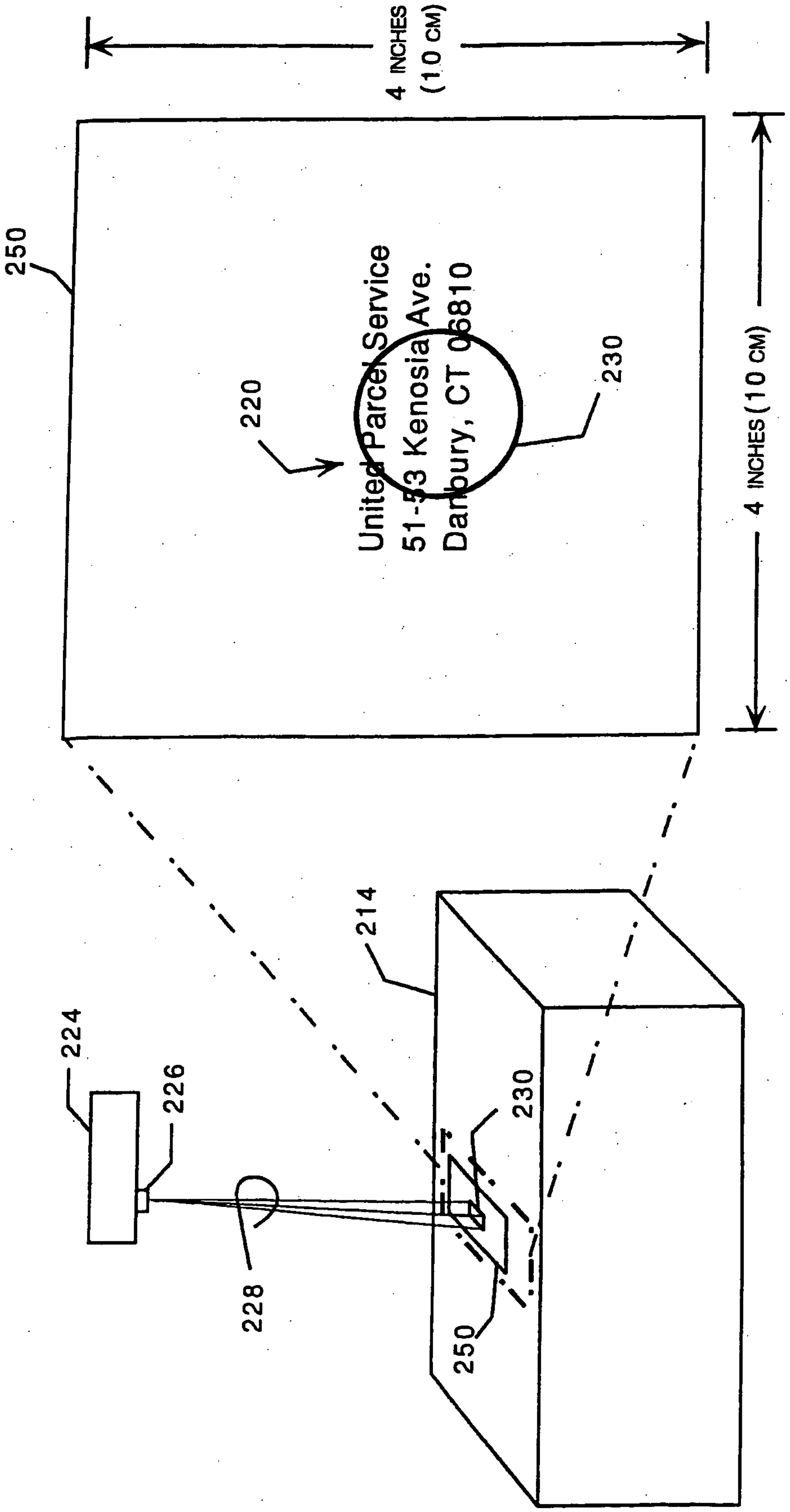
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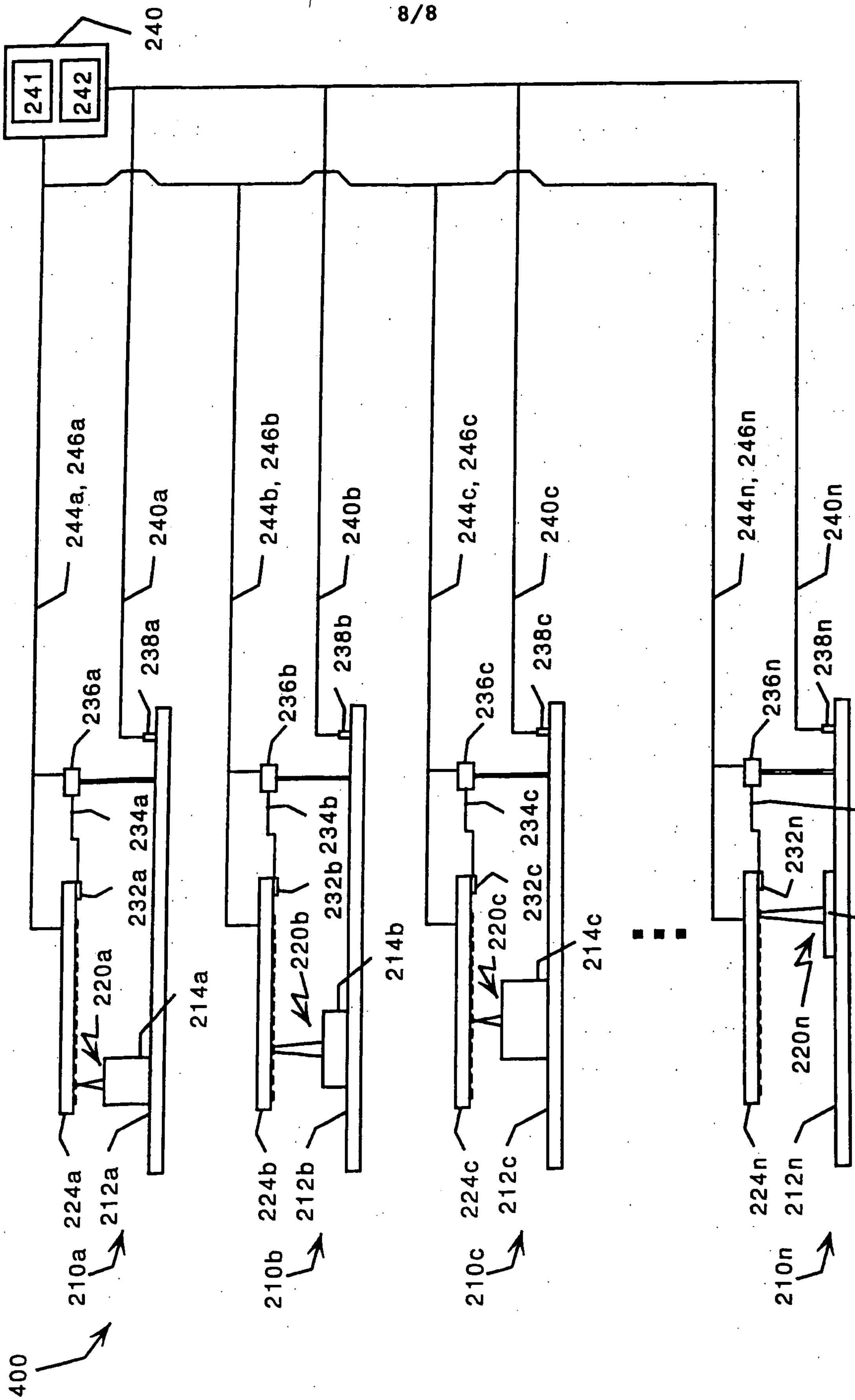
FIG. 3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234c
232c
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238n
236n
234n
232n
214n
220n
224n
212n
210n
400

FIG. 4

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 98/01366

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 B07C3/14

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 B07C G06K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	"parcel positioning scanning and sorting system" IBM TECHNICAL DISCLOSURE BULLETIN, vol. 15, no. 4, September 1972, US, pages 1170-1171, XP002065579	1,2,5-8, 11,13, 14,17-19
A	see the whole document	4,9,16
A	EP 0 647 479 A (GALAI LABORATORIES) 12 April 1995 see the whole document	1,2,5,6, 11,13, 14,17,18
A	EP 0 440 129 A (COMPAGNIE GENERALE D'AUTOMATISME) 7 August 1991	
A	US 5 202 557 A (ROBERTSON) 13 April 1993	
A	GB 1 270 801 A (EMI) 19 April 1972	

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents :

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"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
20 May 1998	03/06/1998

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Forlen, G

2

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/US 98/01366

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 647479 A	12-04-1995	NONE	
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